1. INTRODUCTION

Experimental Design

Characteristics of Living Things

Observations vs Inferences

- ***Observations*** =
  - Noting and recording of FACTS
  - ***Qualitative observations*** =
    - Descriptive characteristics
    - Ex: Mrs. Amos has brown hair.
  - ***Quantitative observations*** =
    - Numbers obtained through counting or measuring
    - Ex: There are 12 computers in the back of the room.

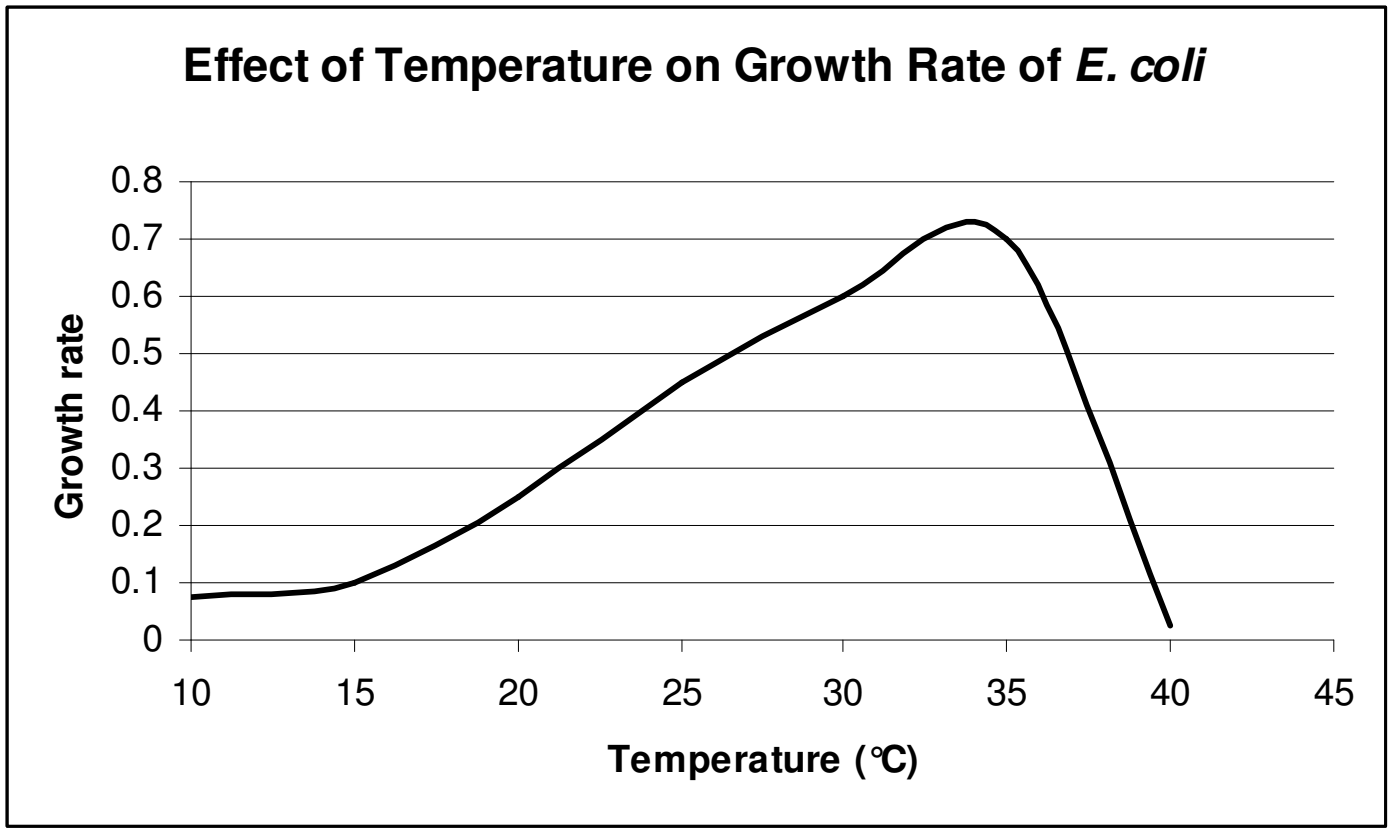
- ***Inferences*** =
  - Logical interpretation based upon prior knowledge and experience
  - Based upon observations
  - Ex: Mrs. Amos is in a good mood. (based on the observation that she is smiling)

- Detailed *observations* should be recorded when collecting data
- *Inferences* may be used when drawing conclusions

Controls and Variables

- ***Control*** = constant
- ***Variable*** = varies

- Only **ONE** factor should be changed at a time
  - ***Independent (or manipulated) variable*** =
    - Factor in a controlled experiment that is deliberately changed
  - ***Dependent (or responding) variable*** =
    - Factor being observed that changes in response to the independent variable



- Independent variable = temperature
  - Found on x-axis
- Dependent variable = growth rate
  - Found on y-axis

- **ALL** other factors should remain constant
  - ***Control group*** =
    - Exposed to same conditions as experiment group except for ONE independent variable
- Example
  - If variable is temperature
  - Then controls could include
    - Type of bacteria
    - Size of petri dish
    - Nutrient broth given

Characteristics of Life

All living things…

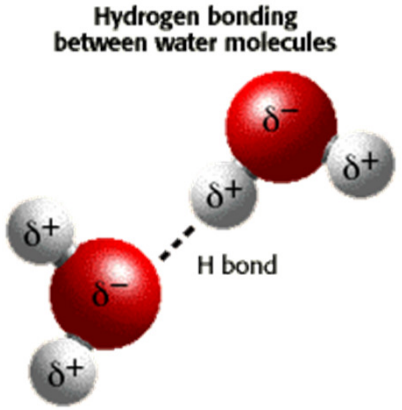
1. Are made up of cells
2. Are based on a universal genetic code
   - Hereditary information stored in **DNA**
3. Obtain and use energy
4. Grow AND develop
5. Reproduce
6. Respond to the environment
7. Maintain a stable internal environment
   - **Homeostasis**: balance!
8. Change over time

2. CHEMISTRY OF LIFE

Chapter 2

Properties of Water

- Polarity
  - Negative pole near oxygen atom
  - Positive pole between hydrogen atoms



- Bonding
  - Polar molecules (like water) can attract each other
  - ***<u>Hydrogen bond</u>*** =
    - Weak attraction between hydrogen atom and another atom
    - Not as strong as covalent or ionic bonds

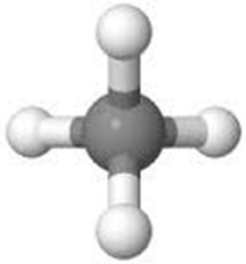
- Water's special properties
  - Water expands slightly at freezing point (0℃)
    - Ice is less dense than water
    - Ice floats, insulating water below it
  - Water dissolves ionic compounds and other polar molecules
  - ***Cohesion*** =
    - Attraction between molecules of the same substance
    - Water molecules are drawn together
      - Produces surface tension
      - Some insects can "walk on water"

- ***Adhesion*** =
  - Attraction between molecules of different substances
  - Ex: Adhesion between water and straw causes water to rise
    - Called capillary action
    - Draws water out of plant roots into stem/leaves

- High ***Specific Heat Capacity*** =
  - Amount of heat energy required to increase temperature
  - Allows large bodies of water to absorb lots of heat with only small changes in temp

Carbon Compounds

- Carbon is very versatile because it can form 4 covalent bonds
  - Can bond with many different elements
  - Can bond to other carbons to form long, complex chains
- ***Monomers*** =
  - Smaller units; building blocks
- ***Polymers*** =
  - Composed of many monomers to make macromolecules



- ***Hydrolysis*** =
  - Splits polymers into monomers
  - Bonds are *broken* through the *addition* of water

- ***Dehydration synthesis*** =
  - Joins monomers into polymers
  - *Forms* bonds through the *removal* of water

Overview of Macromolecules

Macromolecule	Monomer	Function
Carbohydrates	Monosaccharides	Energy
Lipids	Glycerol and Fatty acids	Energy Structure
Nucleic Acids (DNA and RNA)	Nucleotides	Heredity Protein Synthesis
Proteins	Amino Acids	Regulation Structure Transport Protection

Chemical Reactions and Enzymes

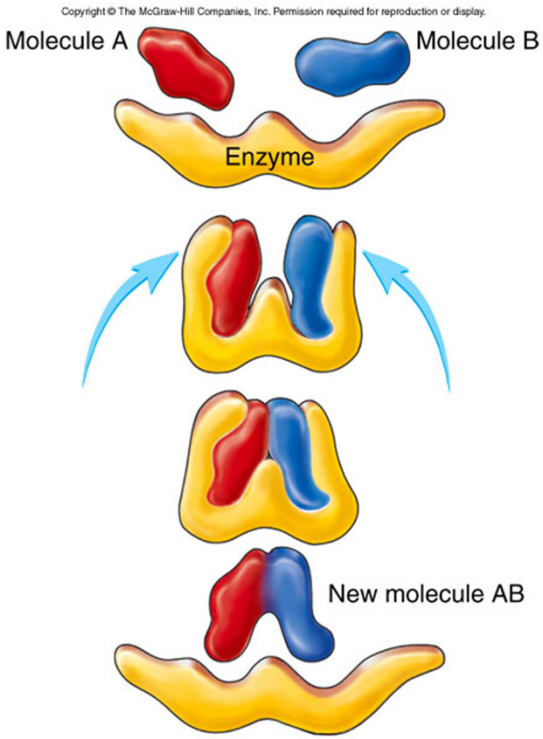
- ***Chemical reactions*** =
  - Change one set of chemicals into another
  - ***Reactants*** =
    - Enter chemical reactions
  - ***Products*** =
    - Produced by chemical reactions

- When chemical bonds are broken
  - Energy is released
- When chemical bonds are formed
  - Energy needs to be absorbed

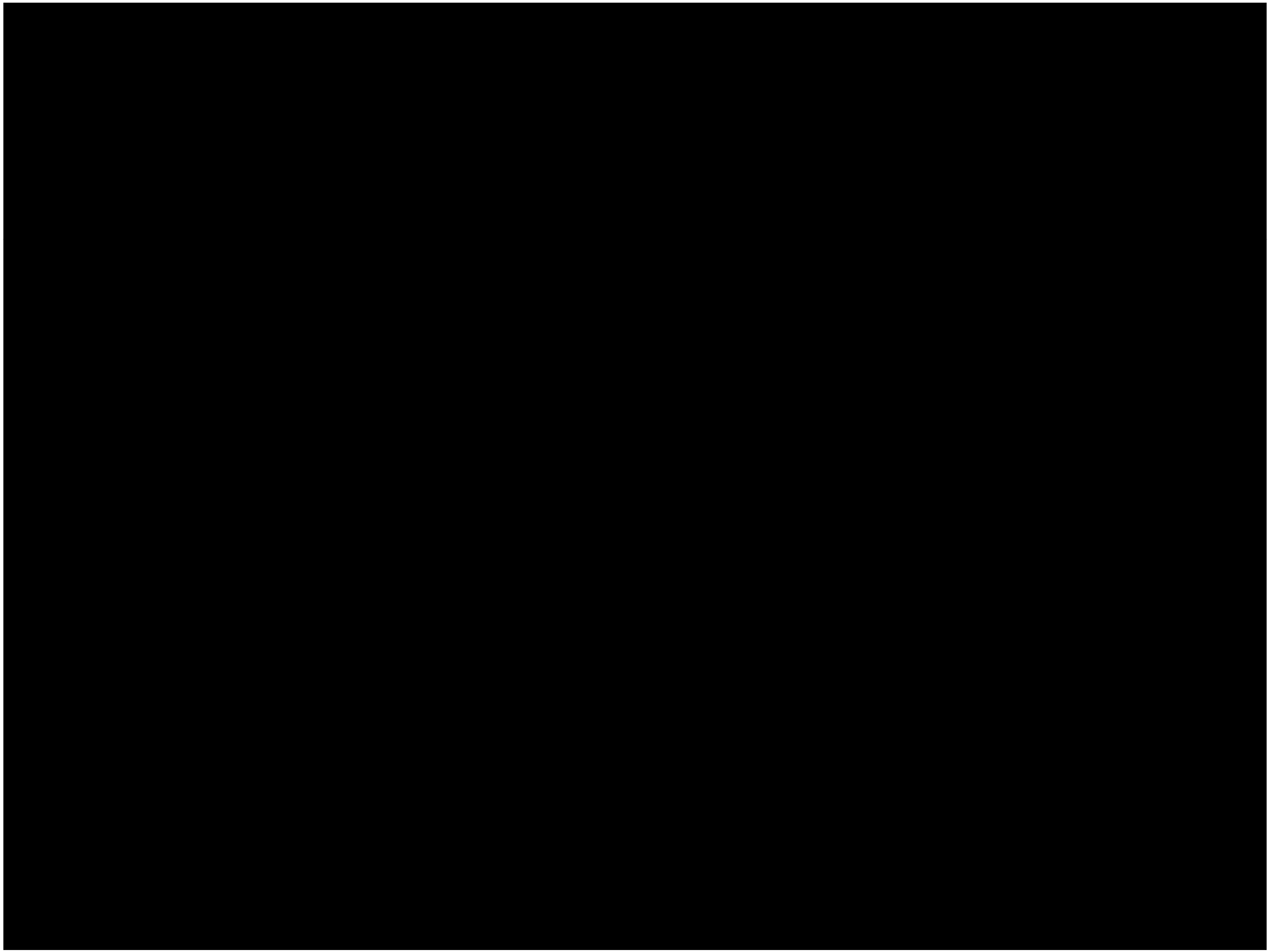
- ***Activation energy*** =
  - Energy necessary to start a chemical reaction
- ***Catalyst*** =
  - Substance that speeds up the rate of a chemical reaction
  - Lowers reaction's activation energy
- ***Enzymes*** =
  - Proteins that act as catalysts
  - Speed up chemical reactions in cells
  - Are NOT permanently changed, so they can be reused

- ***Substrates*** =
  - Reactants in an enzyme-catalyzed reaction
  - Bind to active site on the enzyme

- Shape of enzyme is important!
  - Complementary to substrate
  - Certain enzymes only fit certain substrates for certain reactions
    - Lock and key



- ***Denaturation*** =
  - The change in the **shape** of a protein caused by breaking hydrogen bonds
  - Caused by heat or pH change
  - Makes proteins nonfunctional



3. CELL STRUCTURE AND FUNCTION

Chapter 7

Organelles

- ***Nucleus*** =
  - Control center
  - Contains chromosomes
    - Carry genetic information (DNA)

- ***Ribosomes*** =
  - Proteins are produced here

- ***Endoplasmic reticulum*** =
  - Transports proteins and lipids
  - Rough er has ribosomes attached
  - Smooth er does not
    - Also involved in lipid synthesis and detoxification of drugs

- ***Golgi apparatus*** =
  - Modifies, sorts, and packages proteins and lipids from the ER

- ***Vacuoles*** =
  - Store water and other materials
  - Plants have large central vacuole
- ***Vesicles*** =
  - Store and move materials between organelles and cell surface
- ***Lysosomes*** =
  - Vesicles containing digestive enzymes that clean up the cell
  - Typically found only in animal cells

- ***Cytoskeleton*** =
  - Helps cell maintain shape
  - Involved in movement of and within cell

- ***Centrioles*** =
  - Facilitate movement of chromosomes during cell division
  - Found only in animal cells

- ***Chloroplasts*** =
  - Convert energy from sunlight into chemical energy (glucose) through photosynthesis
  - Found in plants

- ***Mitochondria*** =
  - Convert chemical energy from food into ATP during respiration
  - Inner folds increase surface area to produce more ATP

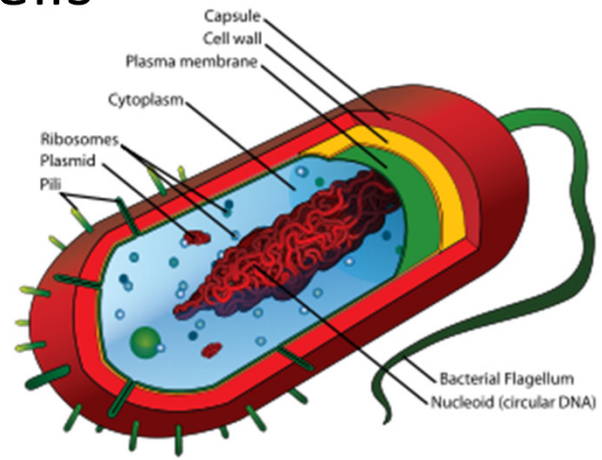
- ***Cell wall*** =
  - Supports, shapes, and protects cell
  - Found in prokaryotes and plant cells
  - NOT found in animal cells

- ***Cell membrane*** =
  - Regulates what enters and leaves cell
  - Composed of lipid bilayer

Compare and Contrast

- All cells have
  - ***Cell membrane*** =
    - Thin, flexible barrier surrounding cell
    - Controls what enters and leaves cell
  - ***Cytoplasm*** =
    - Jelly-like fluid inside cell
  - ***Ribosomes*** =
    - Site of protein synthesis
    - Found throughout cytoplasm
  - DNA
    - Genetic material of the cell

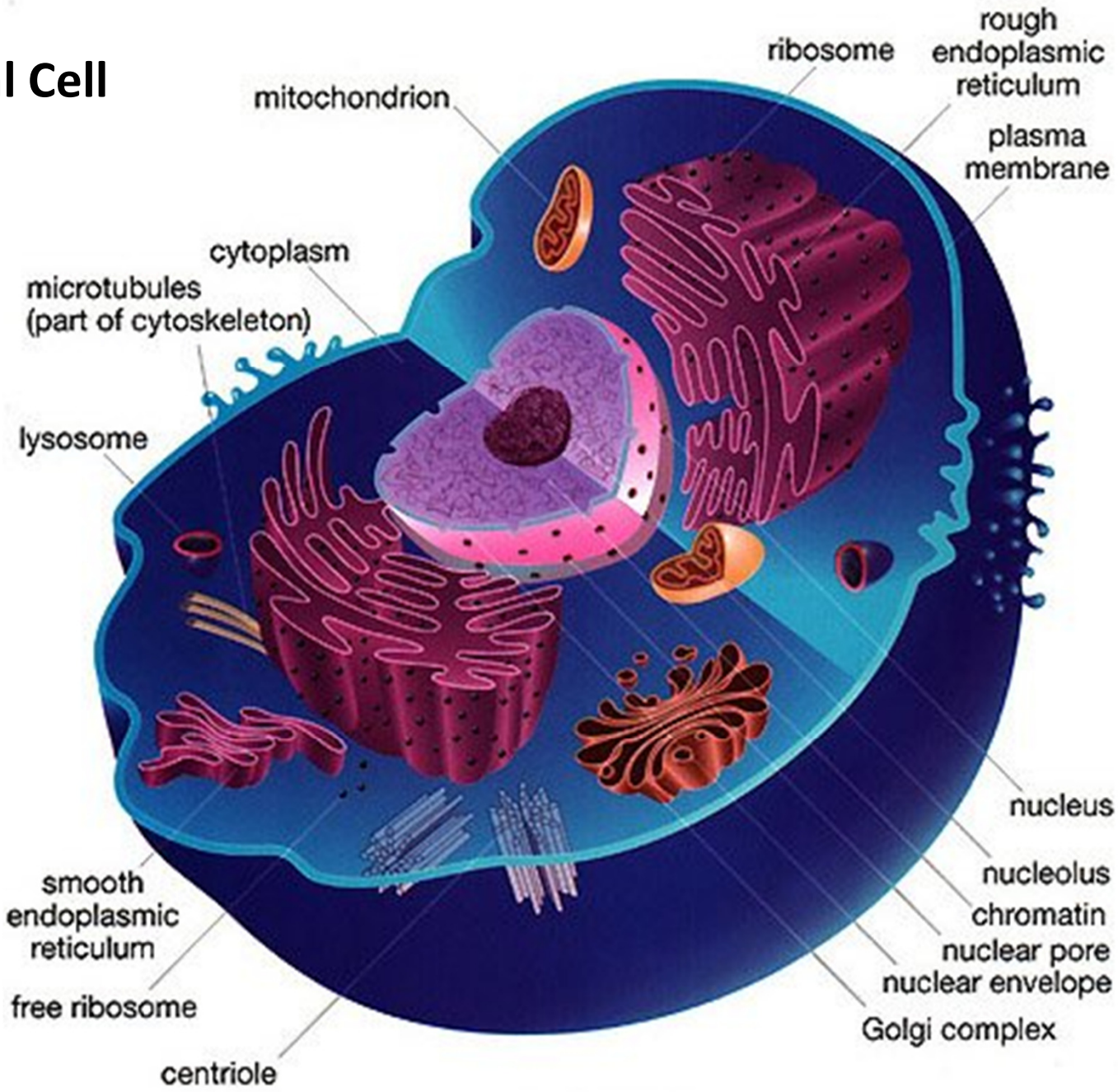
- ***Prokaryotes*** =
  - Unicellular organisms that lack a nucleus
  - DNA is found in cytoplasm
  - Generally smaller and simpler cells
  - Ex: Bacteria

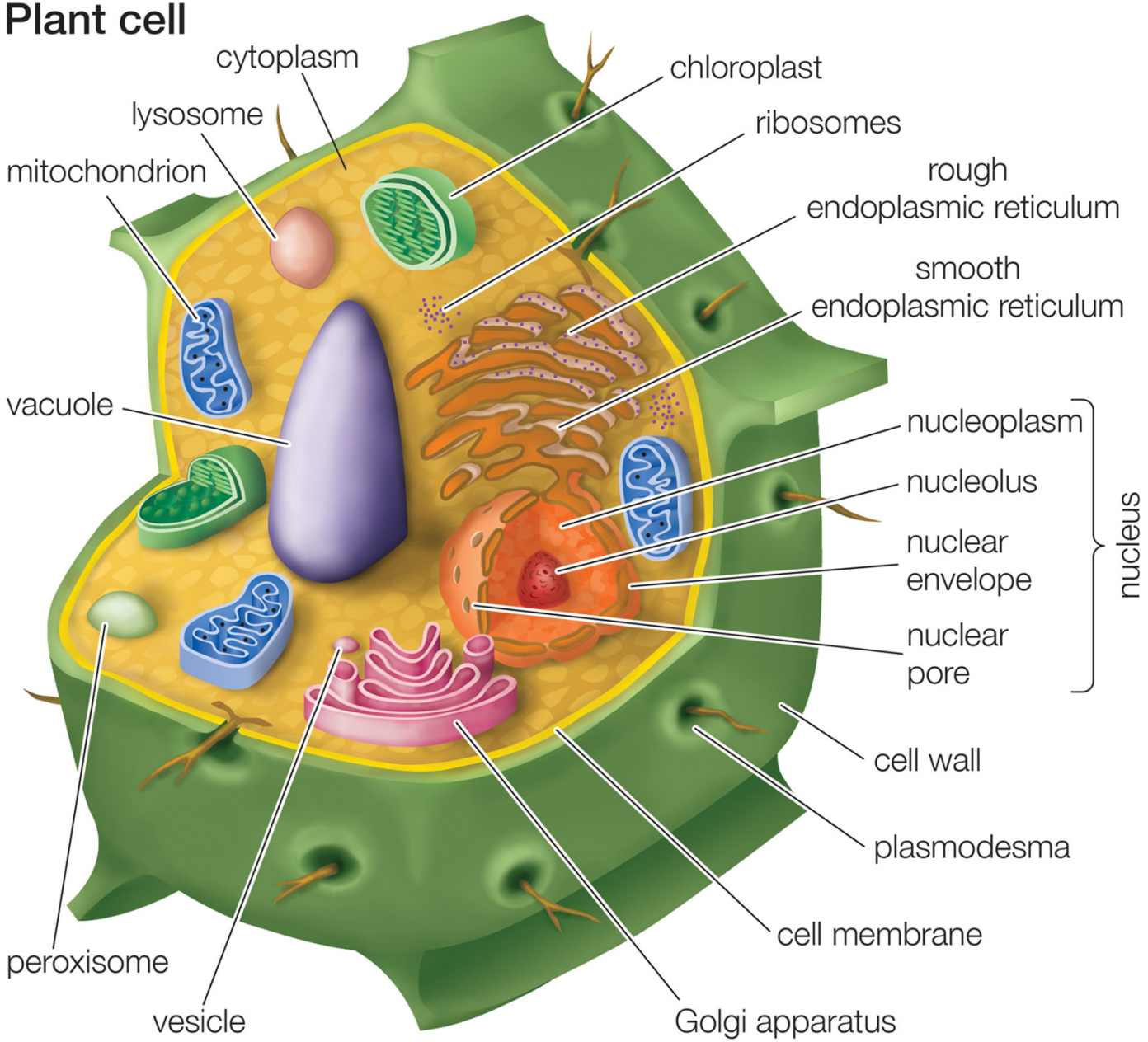


- ***Eukaryotes*** =
  - Cells contain a nucleus
  - DNA is enclosed within nucleus
  - Generally larger and more complex
  - Ex: Protists (unicellular);
    Fungi, Plants, Animals (multicellular)

- Found in plants but NOT animals
  - Chloroplast
  - Cell wall
- Found in animals but NOT plants
  - Lysosomes
  - Centrioles
- Plants have larger, central vacuole

Animal Cell


ribosome
rough endoplasmic reticulum
mitochondrion
plasma membrane
cytoplasm
microtubules (part of cytoskeleton)
lysosome
nucleus
nucleolus
chromatin
nuclear pore
nuclear envelope
Golgi complex
smooth endoplasmic reticulum
free ribosome
centriole



Cell Transport

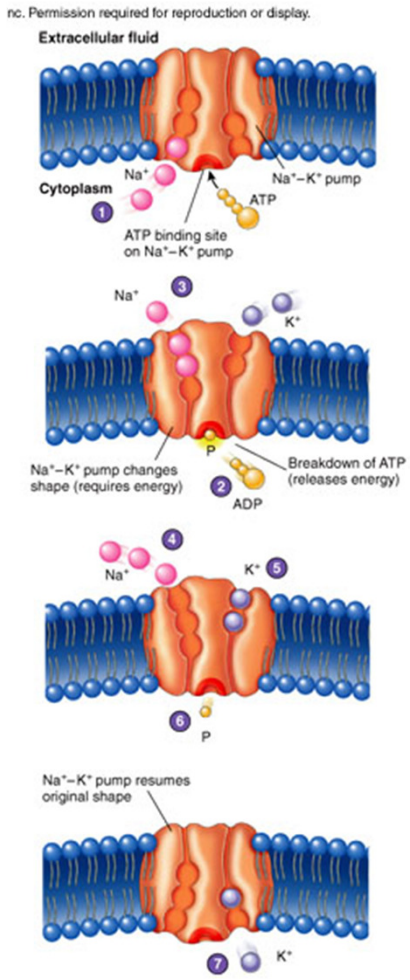
- ***Passive Transport*** =
  - Movement of materials across cell membrane from ***high to low*** concentration
  - Does NOT require energy

  1. ***Diffusion*** =
     - Movement of solute from ***high to low*** concentration
  2. ***Osmosis*** =
     - The diffusion of water across a selectively permeable membrane
     - Water moves from ***high to low***

- If a cell is placed in a
  - **Hypertonic** solution
    - Water moves out of cell
  - **Hypotonic** solution
    - Water moves into cell
    - Ideal for plant cells
  - **Isotonic** solution
    - Water moves in and out of cell
    - Cells neither swell nor shrink
    - Ideal for animal cells

- ***Active Transport*** =
  - Movement of materials from ***low to high*** concentration
  - Requires ***energy!***

1. Molecular transport via protein pumps
   - ATP provides necessary energy
   - Ex: Sodium-potassium pump
     - Moves Na+ out of cells
     - Moves K+ into cells



2. Bulk Transport

- ***Endocytosis*** =
  - Taking material into cell through formation of vesicles
- ***Exocytosis*** =
  - Elimination of material from a cell through the formation of vesicles

Transport Moves Substances

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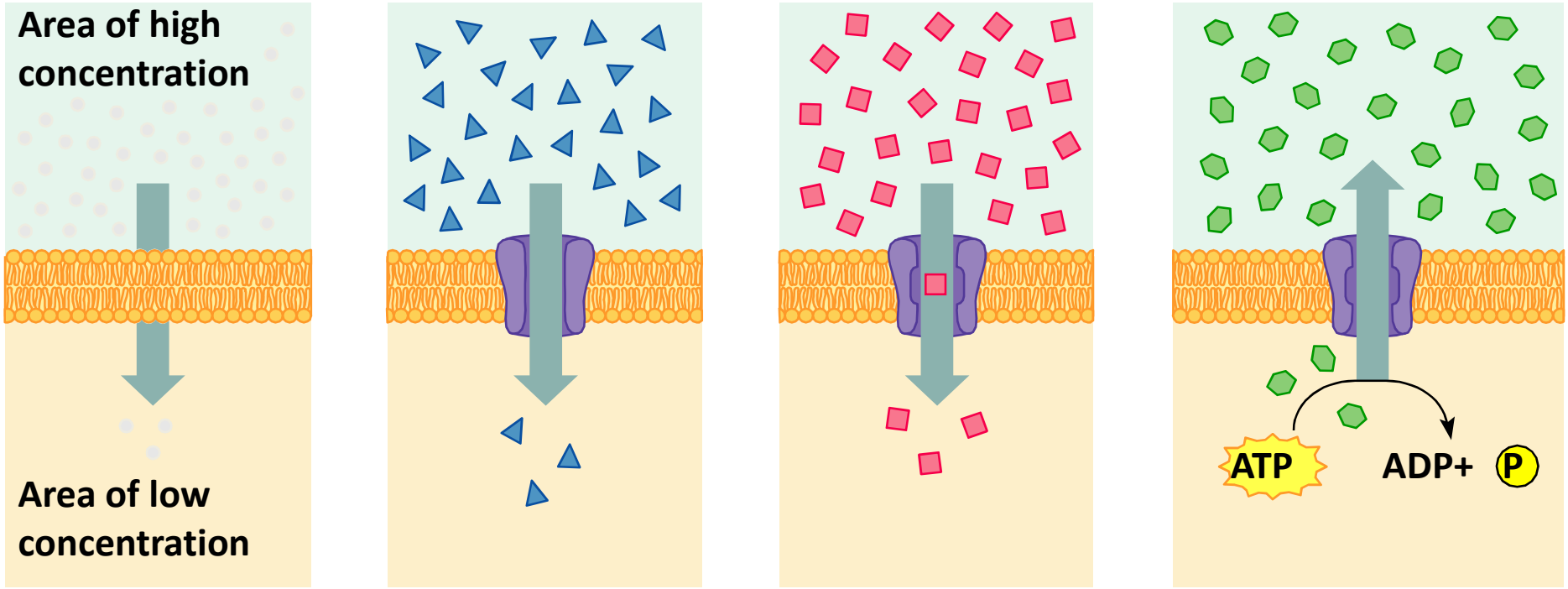

A Simple diffusion

B Facilitated diffusion—channel

C Facilitated diffusion—carrier

D

Passive transport
No energy required

Active transport
Energy required

Endocytosis and Exocytosis

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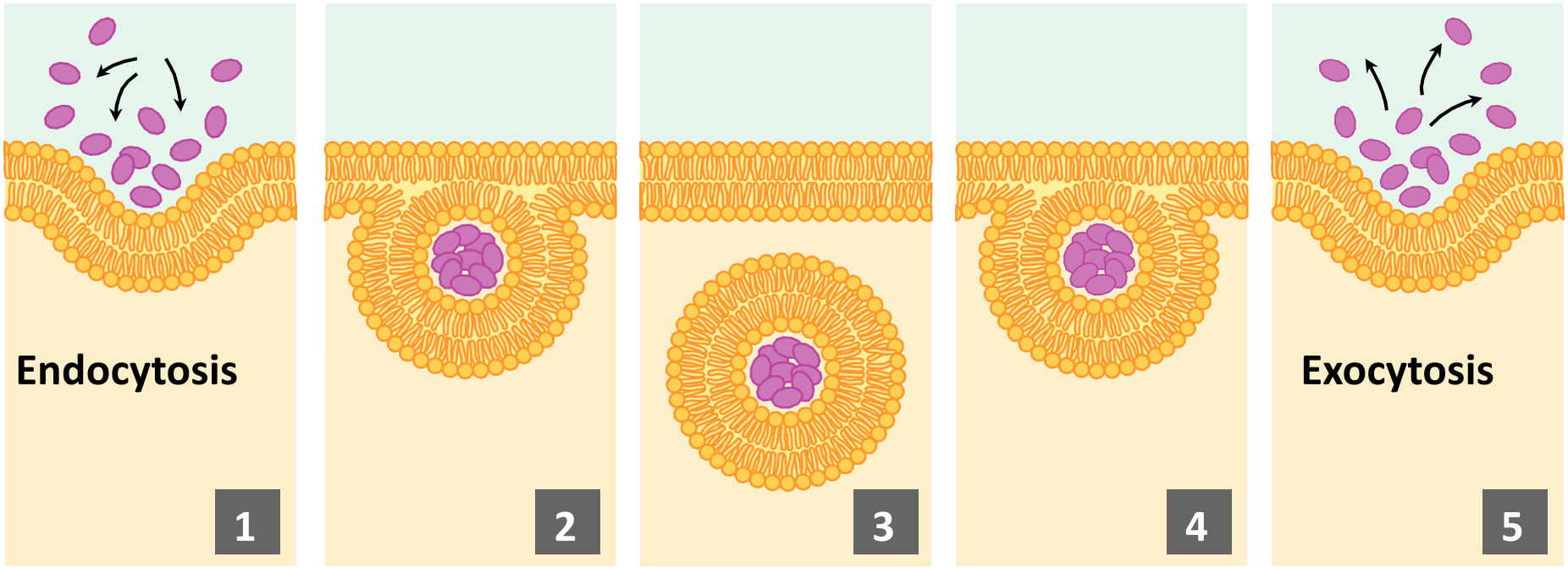


4. PHOTOSYNTHESIS AND RESPIRATION

Chapters 8 and 9

ATP

- Adenosine Triphosphate (ATP)
  - Stores and provides energy

Photosynthesis vs Cellular Respiration

- Opposite processes
  - Energy flows in opposite directions
    - Photosynthesis converts light energy into chemical energy (glucose)
    - Cellular converts chemical energy from food (glucose) into ATP
  - Photosynthesis uses CO_2 and releases O_2
  - Respiration uses O_2 and releases CO_2

- Photosynthesis occurs in plants, algae, and some bacteria
  - Energy conversion occurs in chloroplasts
- Cellular respiration occurs in nearly all living organisms
  - Energy conversion occurs primarily in mitochondria
  - Note: Some organisms use *fermentation* instead to produce energy in the absence of oxygen

- ***<u>Fermentation</u>*** =
  - The process by which cells release energy in the absence of oxygen
    - Anaerobic
  - Occurs in cytoplasm

5. CELL GROWTH AND DIVISION

Chapter 10

- ***Asexual reproduction*** =
  - Genetically identical offspring produced from a single parent
  - Increases population quickly
  - Ex: Bacteria, some plants and simple animals (hydra)

- ***Sexual reproduction*** =
  - Cells from 2 parents unite to form first cell of new organism
  - Increases genetic diversity
  - Ex: Most plants and animals

Cell Division in Eukaryotes

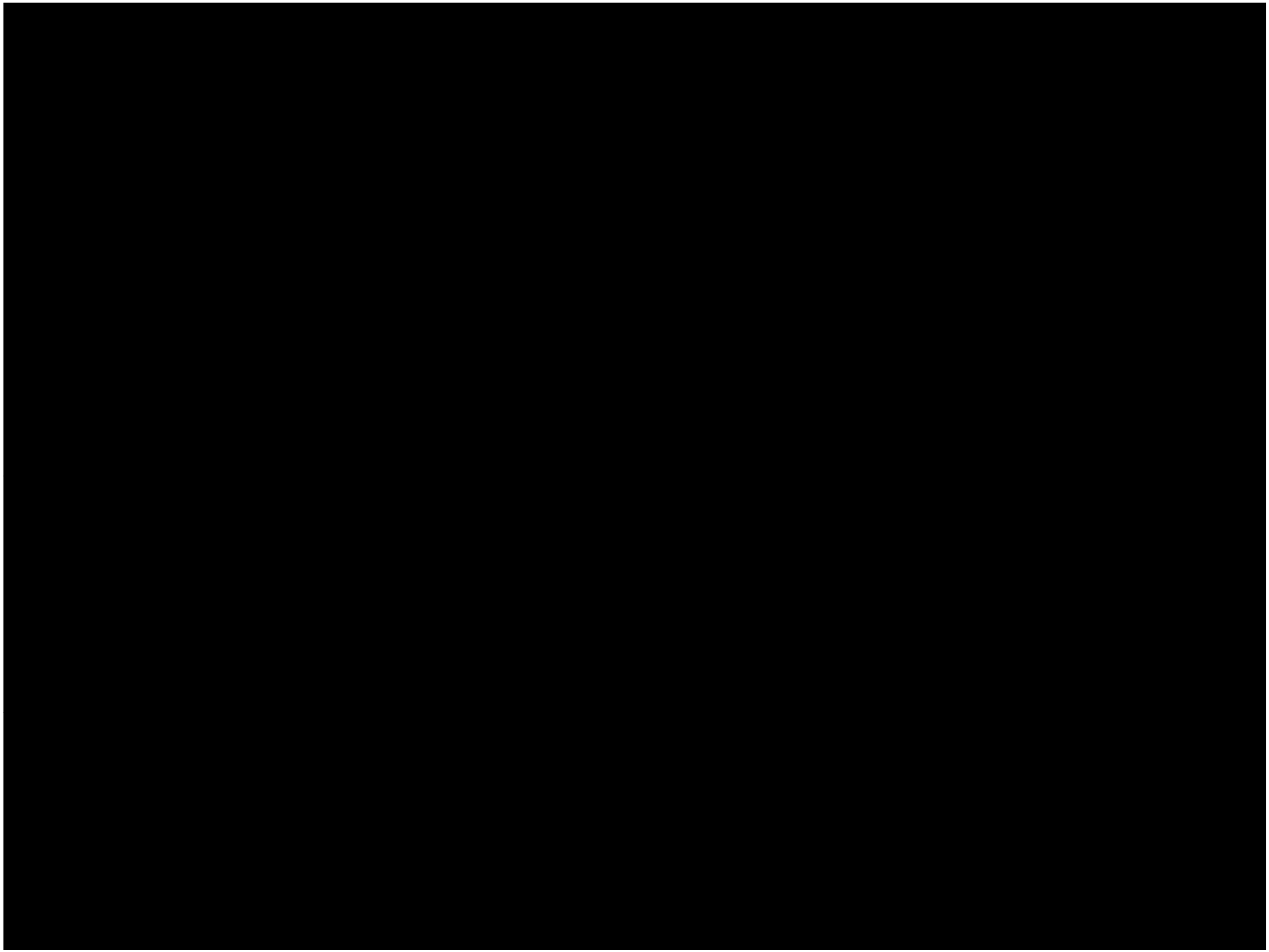
- ***Mitosis*** =
  - Forms new body cells for growth and tissue repair
- ***Meiosis*** =
  - Forms sex cells for reproduction
- ***Apoptosis*** =
  - Programmed cell death

- Coordination of cell division and apoptosis maintains cell numbers

Cell Cycle

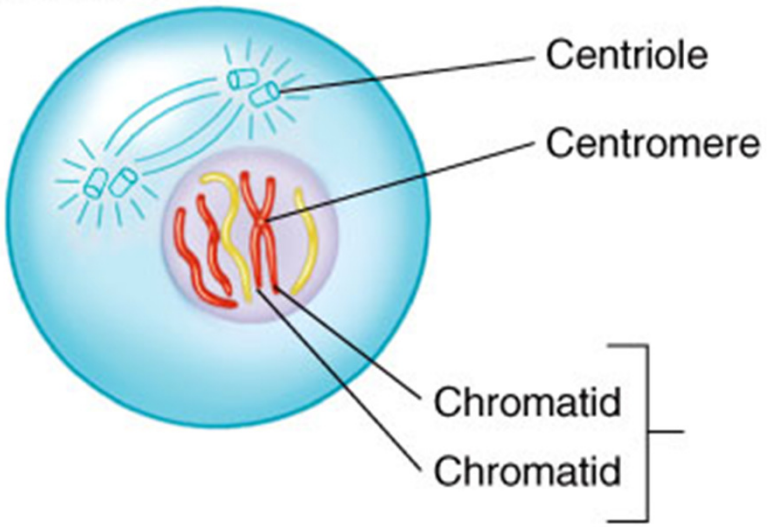
- ***Interphase*** (between cell divisions)
  - Gap phases (G_1 and G_2)
    - Cell grows
    - Proteins and lipids are produced
  - Synthesis phase (S)
    - Chromosomes are copied
- Cell division
  - ***Mitosis*** = division of nucleus
    - 2 identical daughter cells produced
    - Broken down into 4 phases
  - ***Cytokinesis*** = division of cytoplasm

Phases of Mitosis



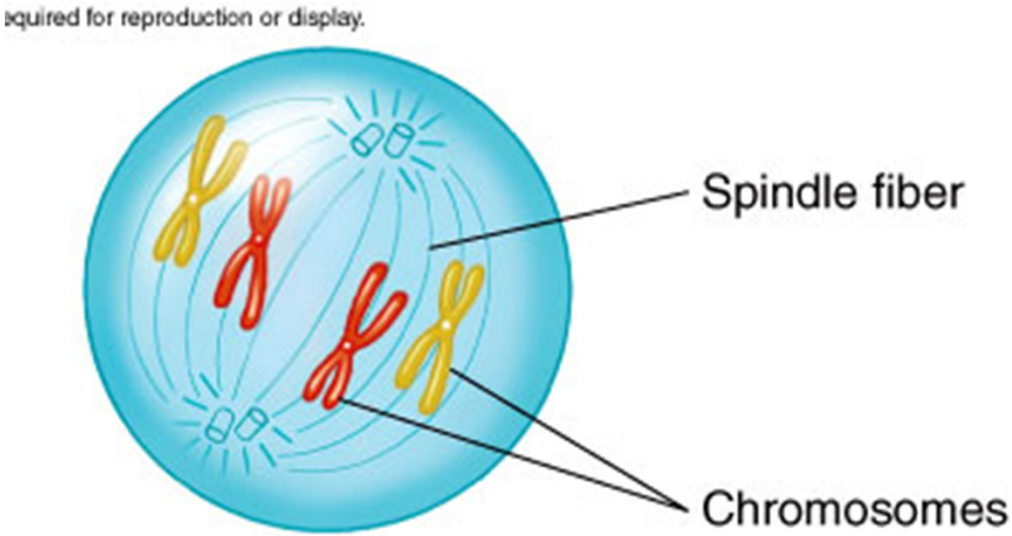
1. Prophase

- First phase of mitosis
- DNA coils tightly and chromosomes become visible
  - Each chromosome is composed of 2 identical strands called ***sister chromatids*** =
    - Identical copies of the same chromosome
  - Paired sister chromatids are attached along ***centromere***
- Nuclear envelope breaks down



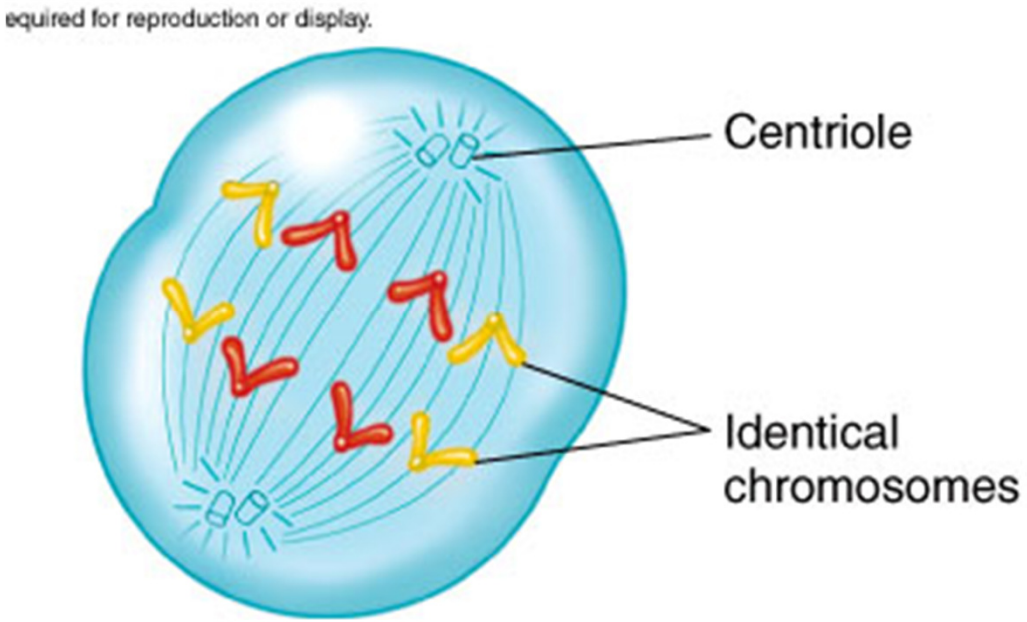
2. **M**etaphase

- Second phase of mitosis
- Chromosomes line up across **M**iddle of cell



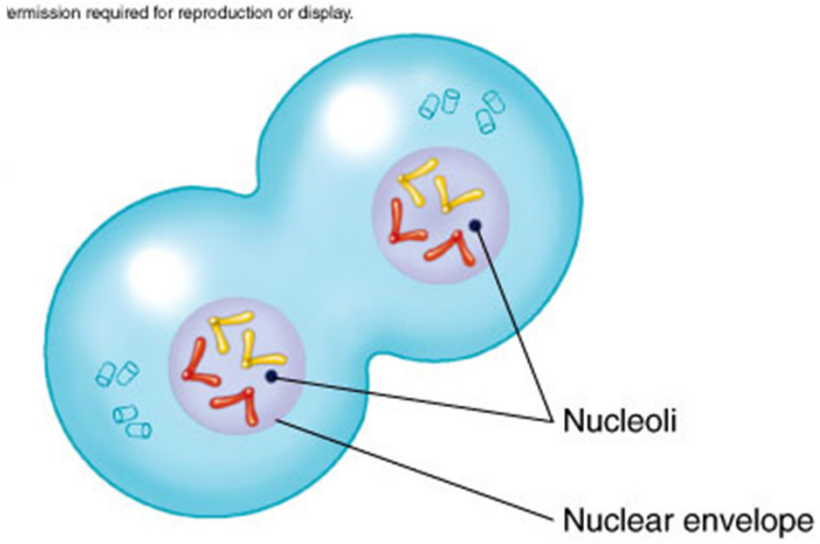
3. **A**naphase

- Third phase in mitosis
- Chromatids separate and move **A**part toward the centrioles at each end of the cell



4. Telophase

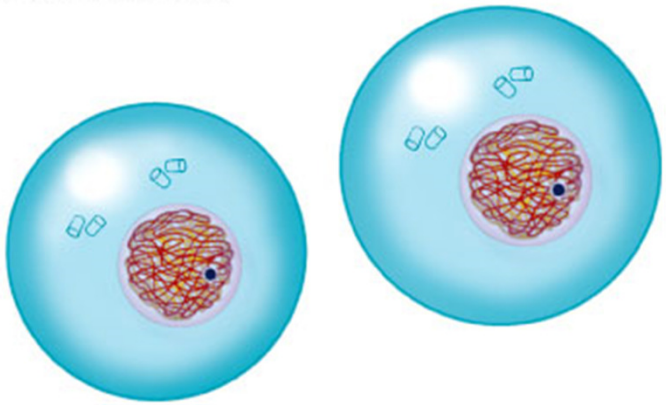
- Fourth phase of mitosis
- Two nuclear envelope reform (one at each end)



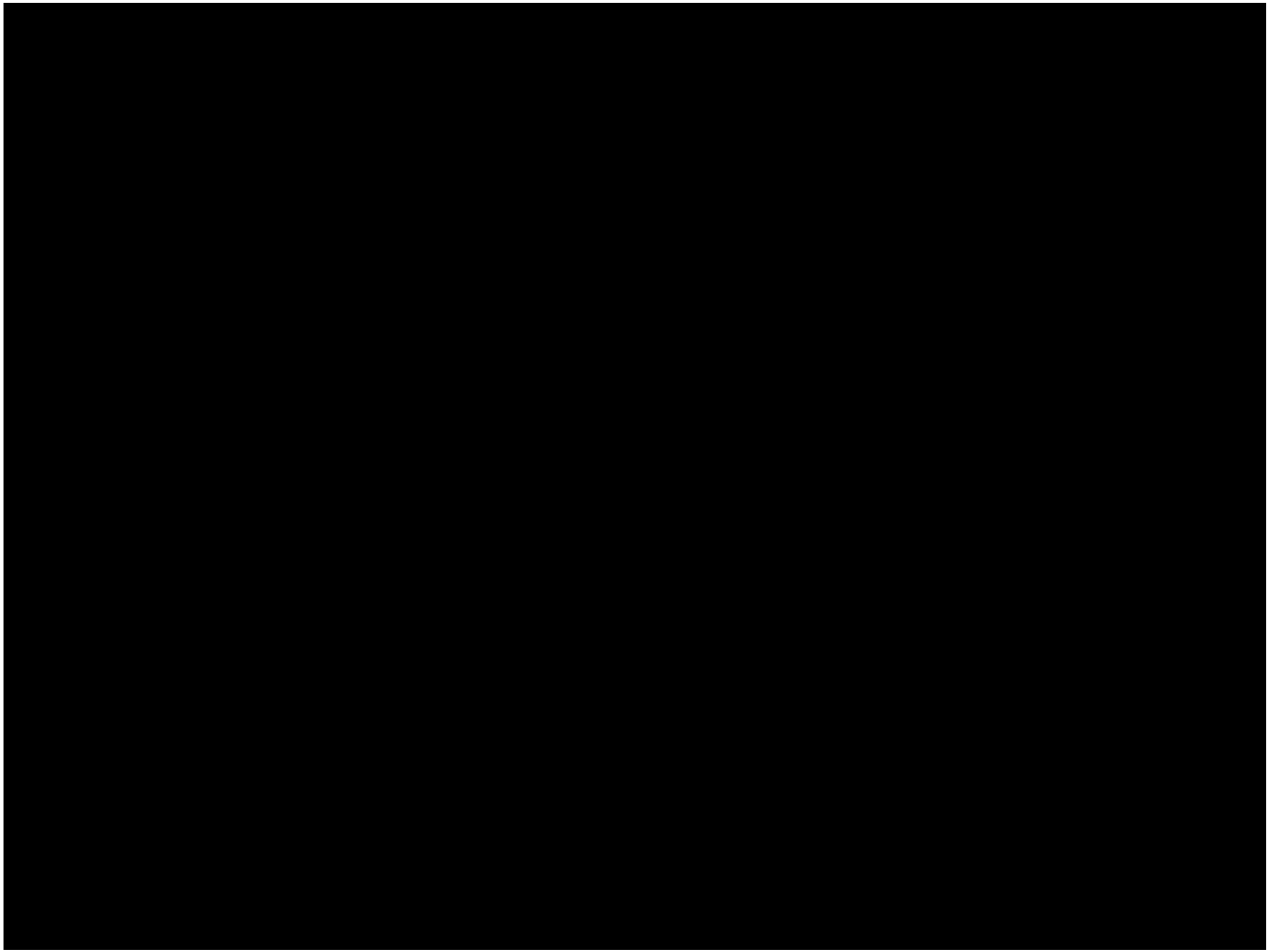
Cytokinesis

Mitosis is followed by ***cytokinesis*** =

- Division of the cytoplasm and its components
- Animal cells
  - Cell membrane pinches inward
- Plant cells
  - Cell plate forms between 2 nuclei

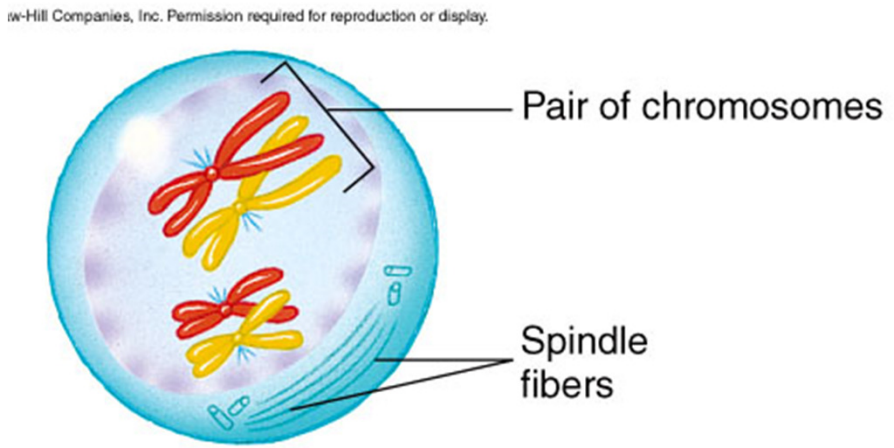


Phases of Meiosis



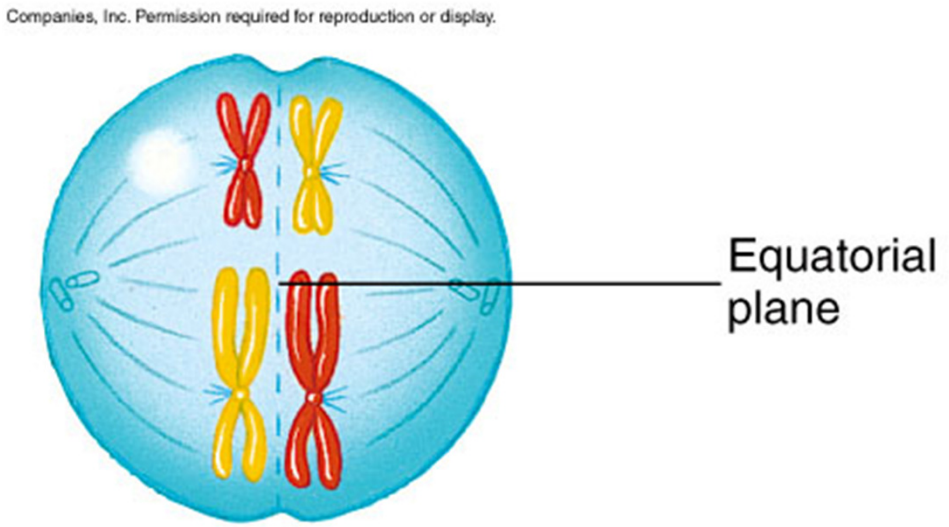
Prophase I

- Replicated chromosomes condense and become visible
- Nuclear envelope fragments
- ***Crossing over*** =
  - Homologs exchange parts
  - Increases genetic diversity!



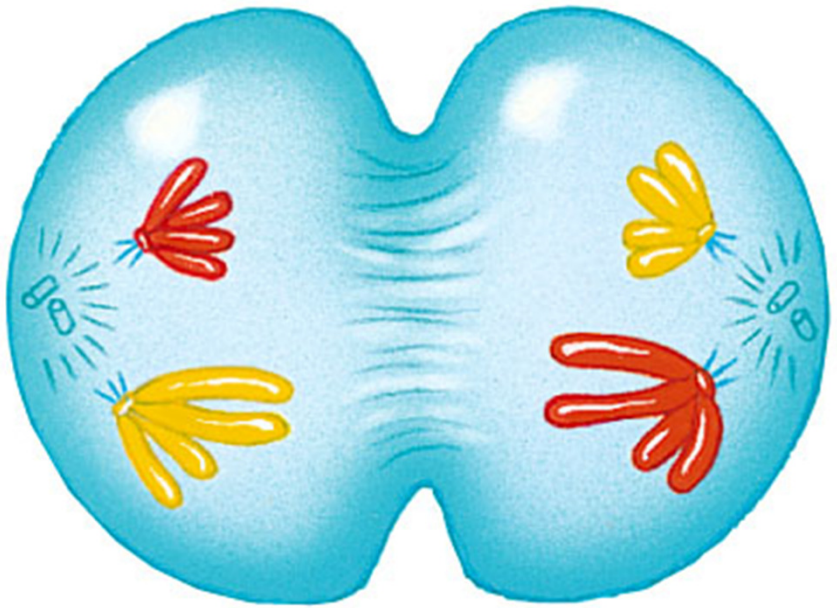
Metaphase I

- Paired homologs line up across **M**iddle of cell
- ***Independent assortment*** =
  - Random alignment of homologs
  - Increases genetic diversity!



Anaphase I

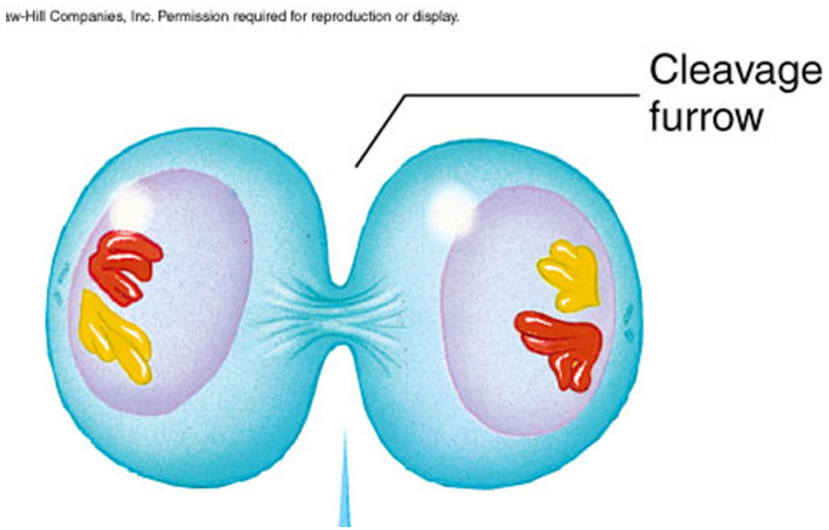
- Homologs move **A**part to opposite poles of cell



Telophase I

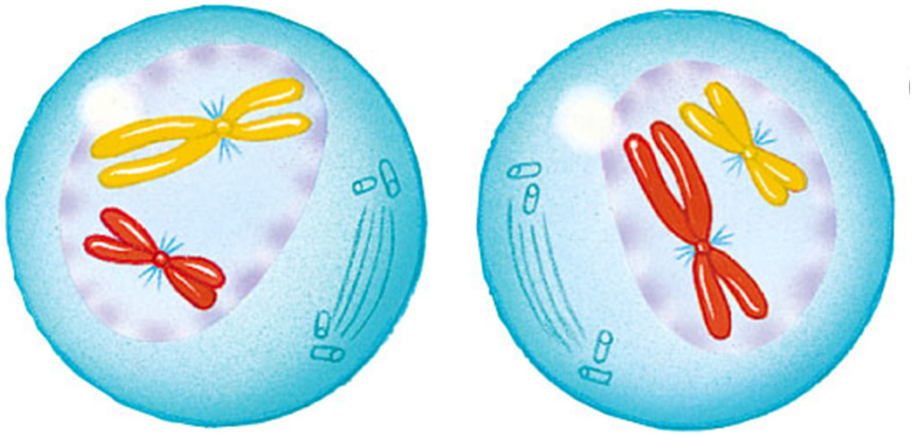
- Two nuclear envelopes partially assemble around chromosomes on either side of cell

- Cytokinesis divides cell into two



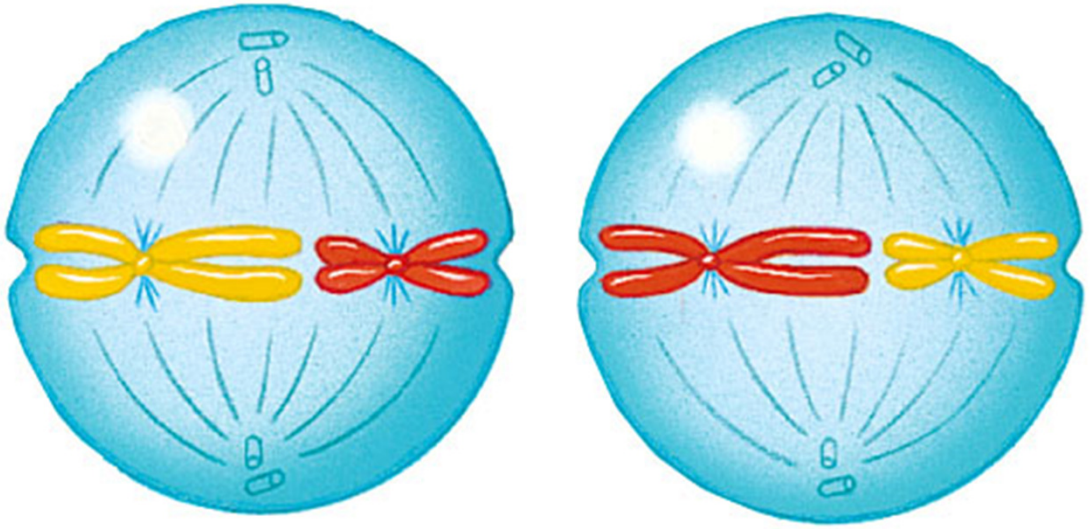
Prophase II

- Chromosomes are again condensed and visible
- Nuclear envelope fragments



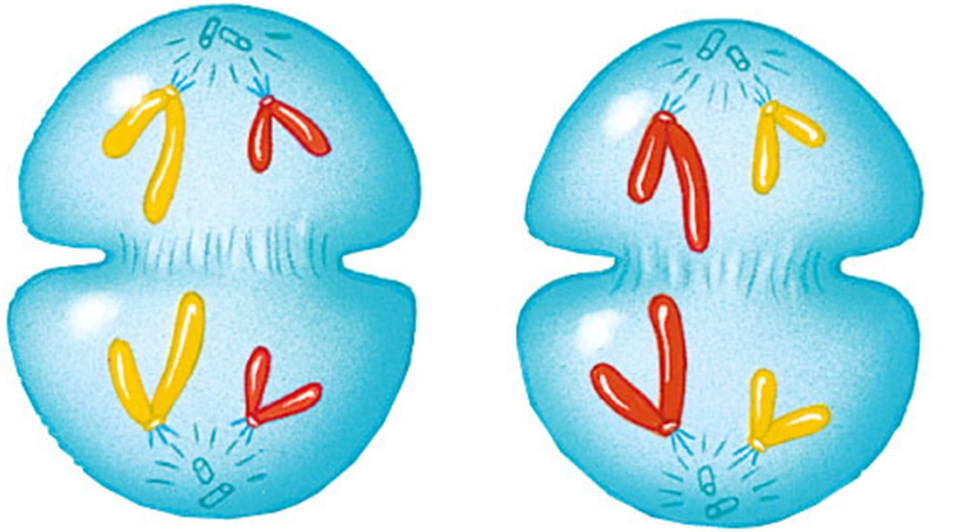
Metaphase II

- Replicated chromosomes line up across middle of cell



Anaphase II

- Sister chromatids separate and move apart to opposite poles

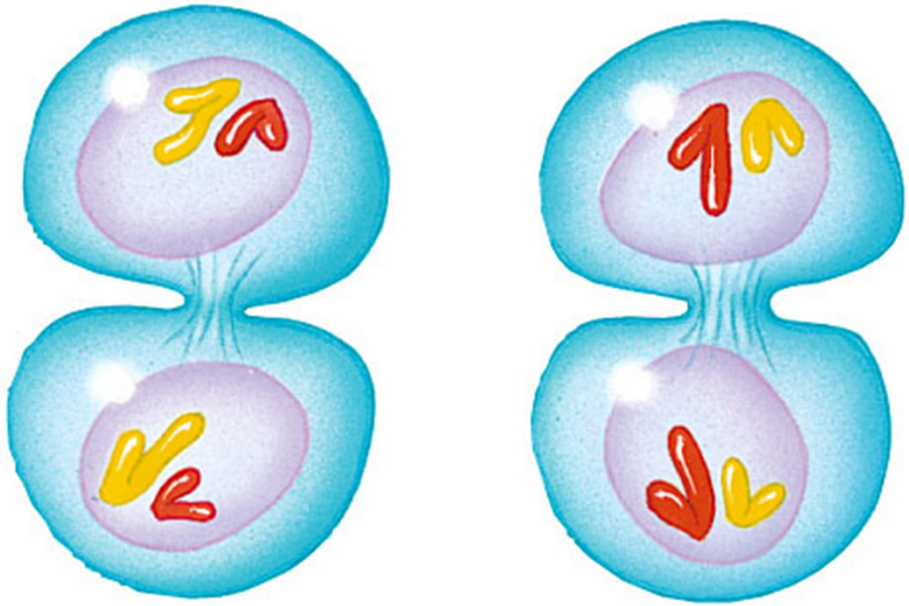


Telophase II

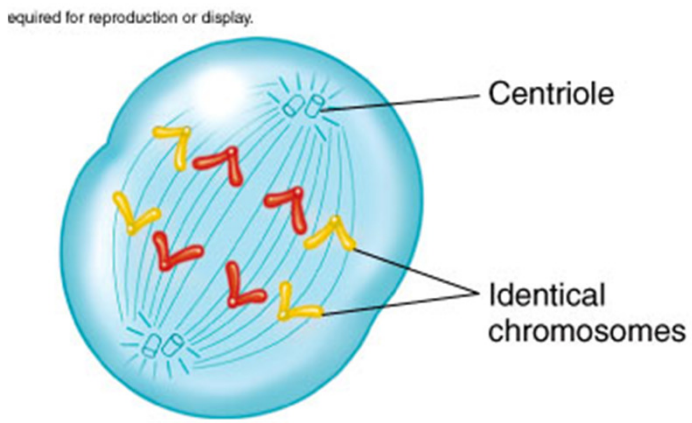
- Nuclear envelopes form around 4 nuclei
- Spindle disappears

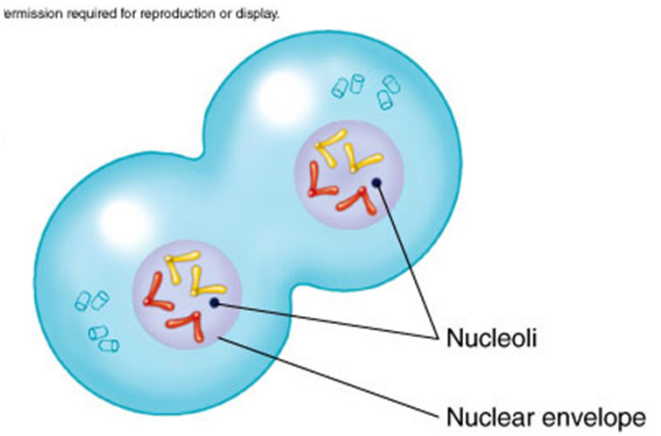
- Cytokinesis divides cells into 4

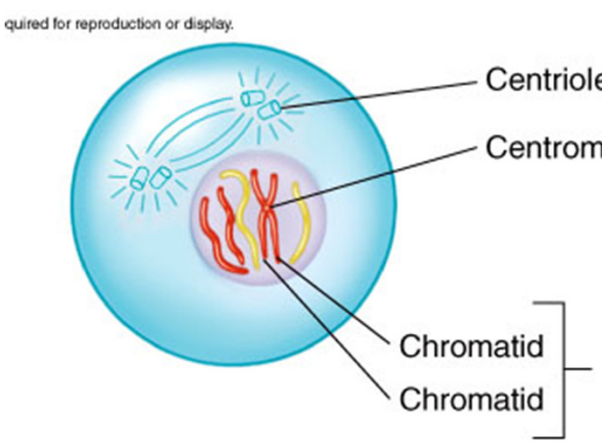
- Result:
  - 4 cells
  - Nonidentical
  - Haploid

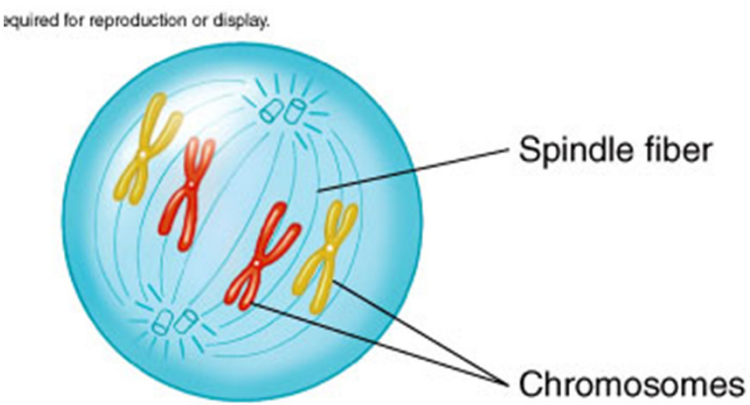


Name the Phase of Mitosis

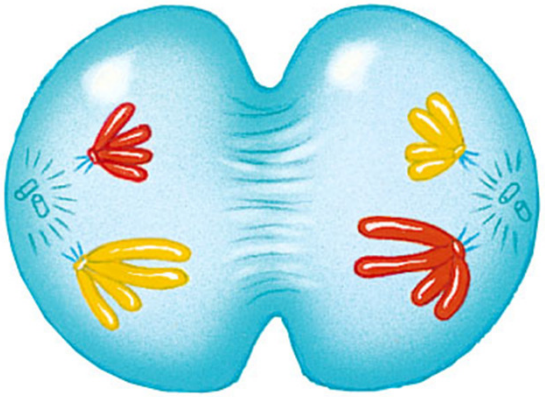


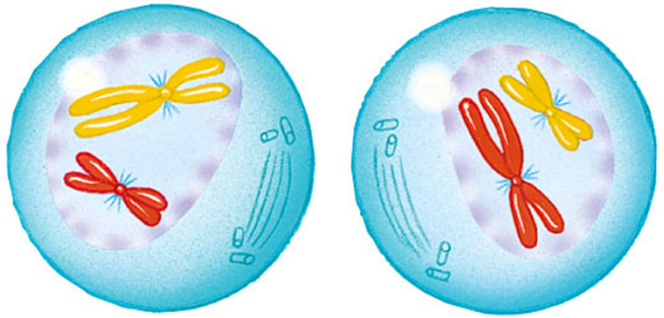


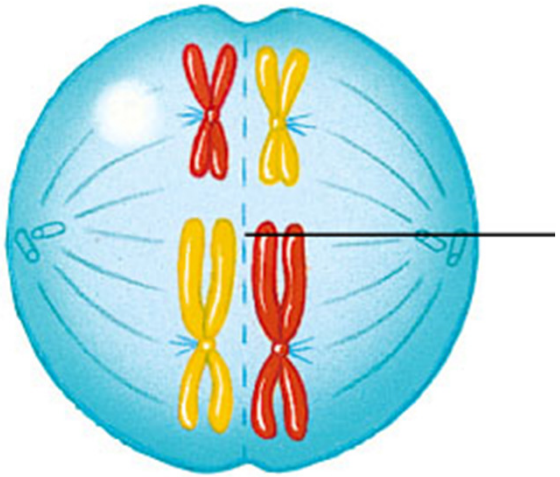


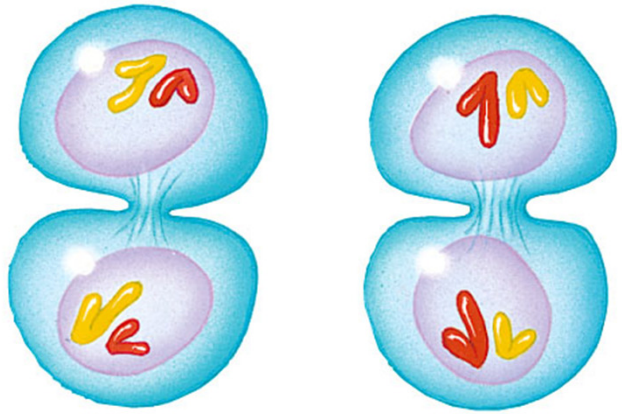


Name the Phase of Meiosis

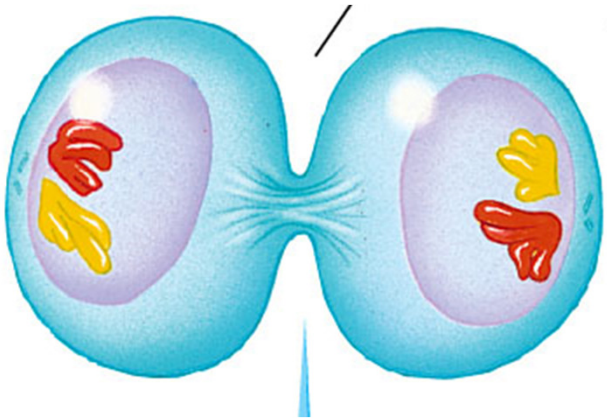


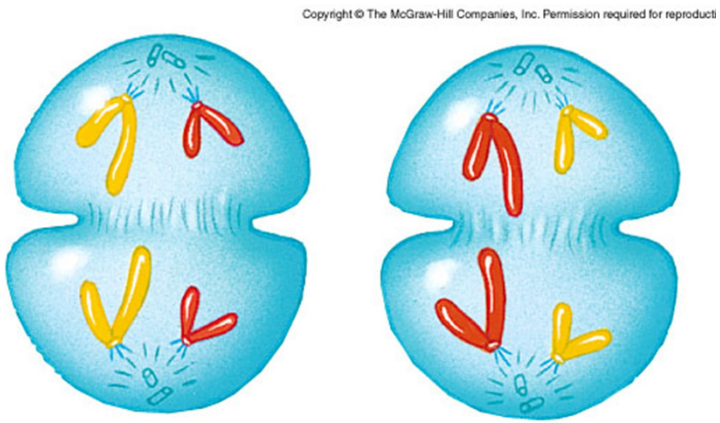


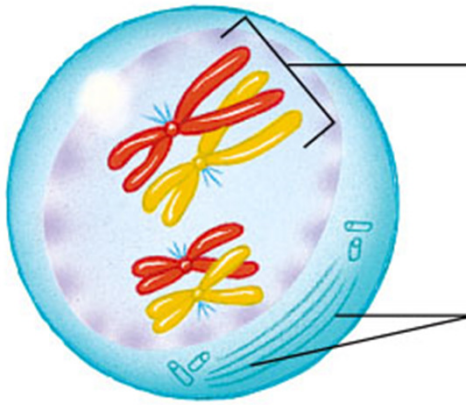


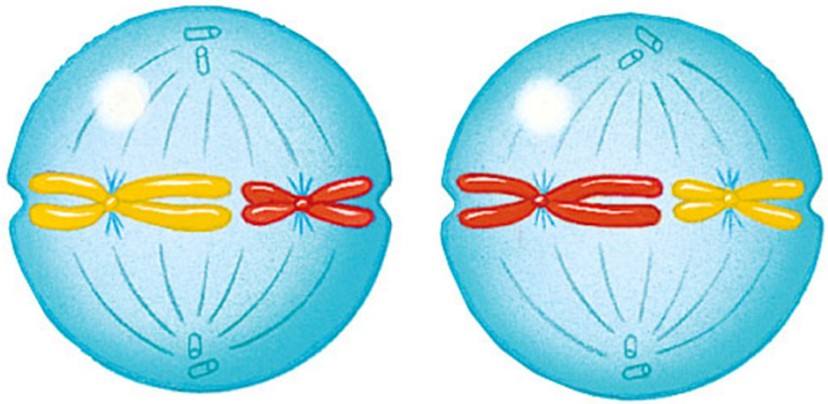


Name the Phase of Meiosis







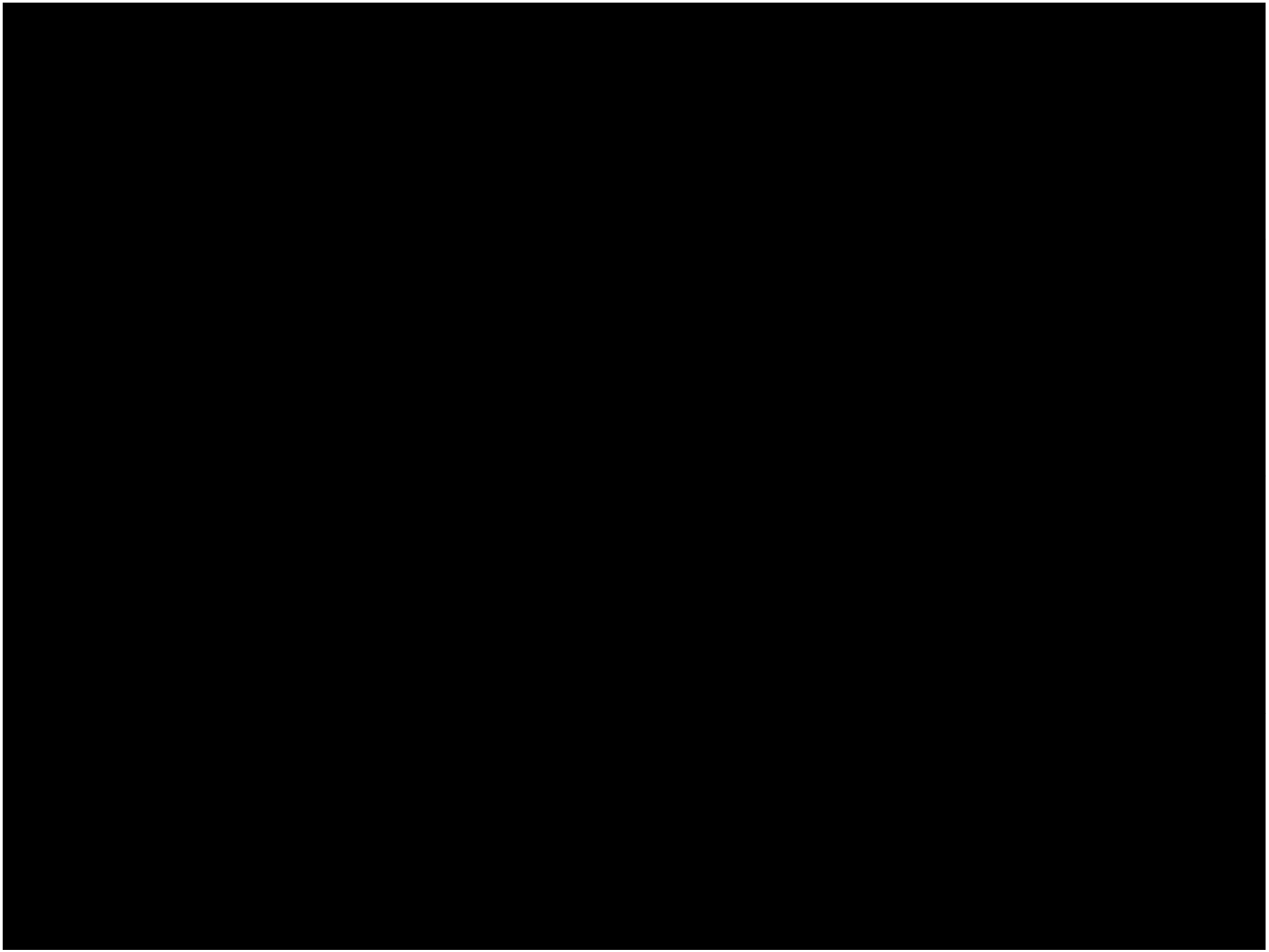


Mitosis

- One division
- 2 daughter cells
- Daughter cells genetically identical
- Chromosome # of daughter cells same as that of parent cell (diploid)
- Occurs in body cells
- Used for growth, repair, and asexual reproduction

Meiosis

- Two divisions
- 4 daughter cells
- Daughter cells genetically different
- Chromosome # of daughter cells half that of parent cell (haploid)
- Occurs in reproductive cells
- Used for sexual reproduction, producing new gene combinations



Errors in Cell Division

- ***Nondisjunction*** =
  - Homologous chromosomes do not separate properly
  - Error in anaphase
  - Results in abnormal chromosome number
  - ***Monosomy*** =
    - One missing chromosome
  - ***Trisomy*** =
    - One extra chromosome

- Nondisjunction of autosomes could result in:
  - Down syndrome (Trisomy 21)
    - Mental retardation and birth defects
  - Edward syndrome (Trisomy 18)
  - Patau syndrome (Trisomy 13)
- Nondisjunction of sex chromosomes could result in:
  - Turner syndrome (XO)
    - Sterile female
  - Klinefelter syndrome (XXY)
    - Male (typically unable to reproduce)
  - Note: Y with no X won't even be born

6. GENETICS

Chapter 11

Punnett Squares and Pedigrees

Mendelian Inheritance

Tall (T) is dominant over short (t)

Cross the following:

2 heterozygous tall plants

Tt x Tt

Probability offspring is tall?

Probability offspring is short?

Cross the following:

A heterozygous tall plant with a short plant

Tt x tt

Probability offspring is tall?

Probability offspring is short?

Incomplete Dominance

Red flowers (R) are incompletely dominant over white flowers (W); The heterozygote RW = pink

Cross the following:

2 pink flowers

RW x RW

Probability offspring is pink?

Probability offspring is red?

Probability offspring is white?

Cross the following:

A red flower with a white flower

RR x WW

Probability offspring is pink?

Probability offspring is red?

Probability offspring is white?

Codominance

Red coat color (R) is codominant with
white coat color (W);
The heterozygote RW = roan (red AND white)

Cross the following:

A red cow and a white bull

RR x WW

Probability offspring is roan?

Probability offspring is red?

Probability offspring is white?

Cross the following:

A roan cow with a roan bull

RW x RW

Probability offspring is roan?

Probability offspring is red?

Probability offspring is white?

Multiple Alleles

Blood Types:

I^AI^A and I^Ai = A

I^BI^B and I^Bi = B

I^AI^B = AB

ii = O

Cross the following:

Heterozygous A with Heterozygous B

$I^Ai \times I^Bi$

Probability offspring has type A?

Probability offspring has type B?

Probability offspring has type AB?

Probability offspring has type O?

Cross the following:

Type AB with Type O

$I^AI^B \times ii$

Probability offspring has type A?

Probability offspring has type B?

Probability offspring has type AB?

Probability offspring has type O?

Sex-Linked

Colorblindness is a recessive X-linked disorder

X^NX^N and X^NX^n = normal female

X^nX^n = colorblind female

X^NY = normal male

X^nY = colorblind male

Cross the following:

Heterozygous normal female and normal male

$X^NX^n \times X^NY$

Probability offspring is normal?

Probability offspring is colorblind?

Cross the following:

Heterozygous normal female and colorblind male

$X^NX^n \times X^nY$

Probability offspring is normal?

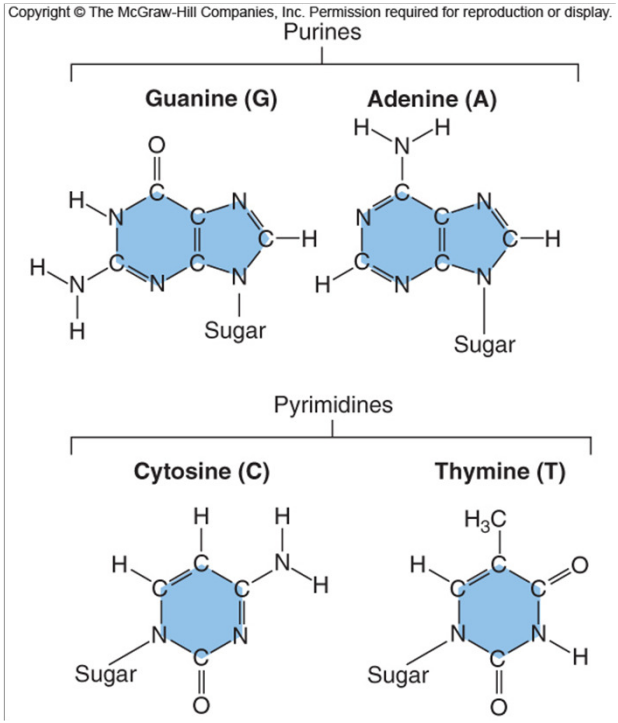
Probability offspring is colorblind?

7. DNA and Chromosomes

Chapter 12

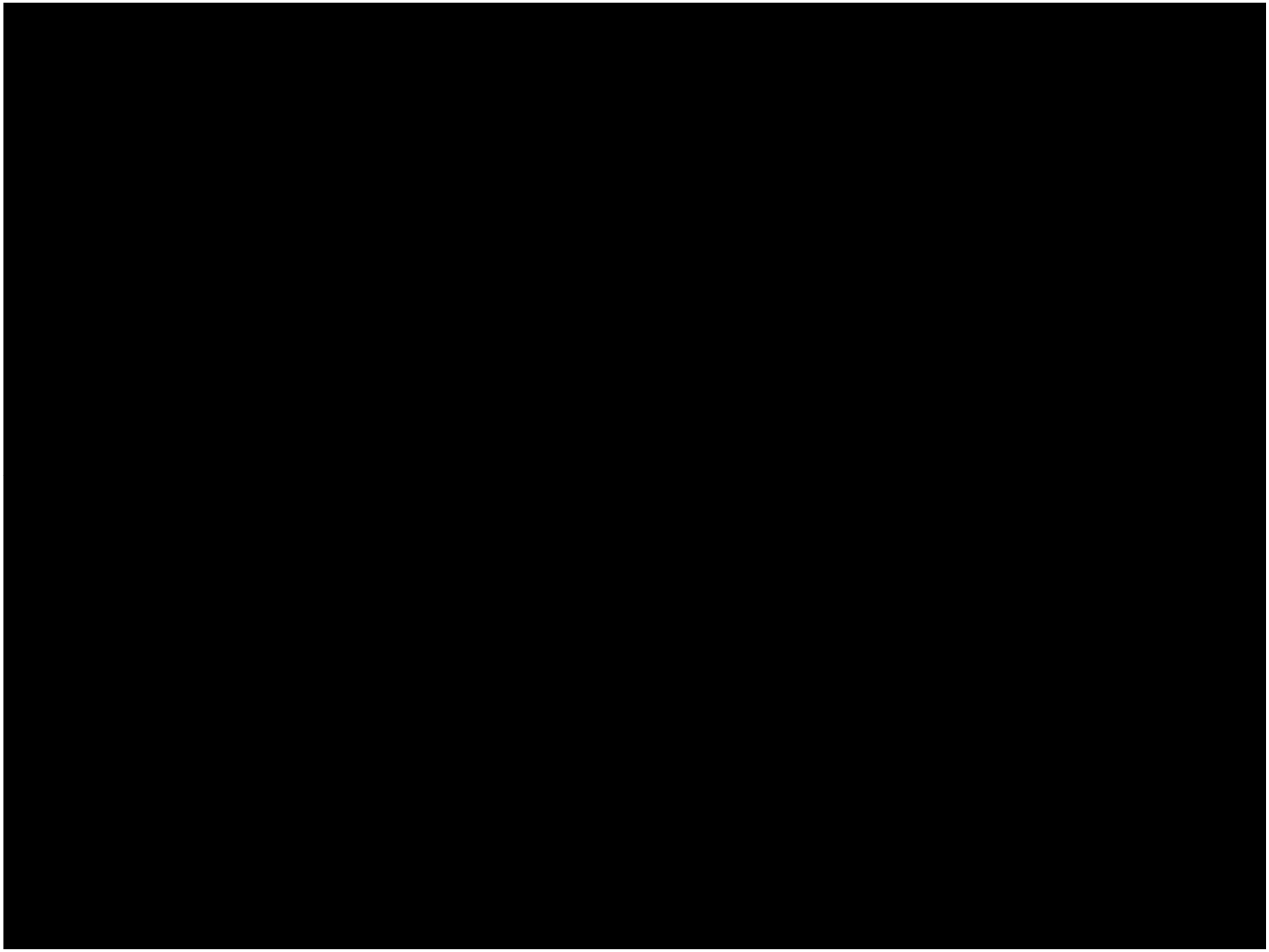
Structure of DNA

- Building blocks of nucleic acids = ***<u>nucleotides</u>***
  - 1 sugar (deoxyribose)
  - 1 phosphate group
  - 1 nitrogenous base
    - Adenine (A)
    - Guanine (G)
    - Cytosine (C)
    - Thymine (T)



- Nucleotides join to form long chains
  - Sugar-phosphate backbone
    - Strands are antiparallel
    - 5 prime (5') and 3 prime (3') ends
  - Nitrogenous bases held to those of 2nd strand by weak hydrogen bonds
    - Complementary base pairs
      - **A bonds with T**
      - **C bonds with G**
- Double helix forms when antiparallel, base-paired strands twist

- ***Semiconservative replication*** =
  - Each replicated DNA molecule has one original strand and one new strand
- Overview
  1. Strands unwind and separate at several points
  2. ***DNA polymerase*** adds complementary bases to template
     - **A with T and vice versa**
     - **G with C and vice versa**
  3. Sugar-phosphate backbones seal back up
- Result
  - 2 DNA molecules
  - Identical to each other and original



DNA Replication Practice

- DNA template strand

C C T A G C T A C

- Replicated strand

G G A T C G A T G

8. RNA and PROTEIN SYNTHESIS

Chapter 13

DNA

- Double stranded
- Thymine
- Sugar is Deoxyribose

RNA

- Single stranded
- Uracil
- Sugar is Ribose

- Types of RNA
  1. Messenger RNA (mRNA)
     - Carries copies of instructions from DNA to ribosomes
  2. Ribosomal RNA (rRNA)
     - Important component of ribosomes
  3. Transfer RNA (tRNA)
     - Carries amino acids to ribosomes during protein synthesis

- ***Transcription*** =
  - Synthesis of RNA from DNA template
  - Eukaryotes
    - Occurs in nucleus
  - Prokaryotes
    - Occurs in cytoplasm

- ***Translation*** =
  - mRNA is converted into sequence of amino acids of a protein
  - Eukaryotes AND prokaryotes
    - Occurs in cytoplasm at ribosomes

Transcription and Translation Practice

- DNA template strand

  TACGGTCGTTCGAATATC

- mRNA codons

  AUG CCA GCA AGC UUA UAG

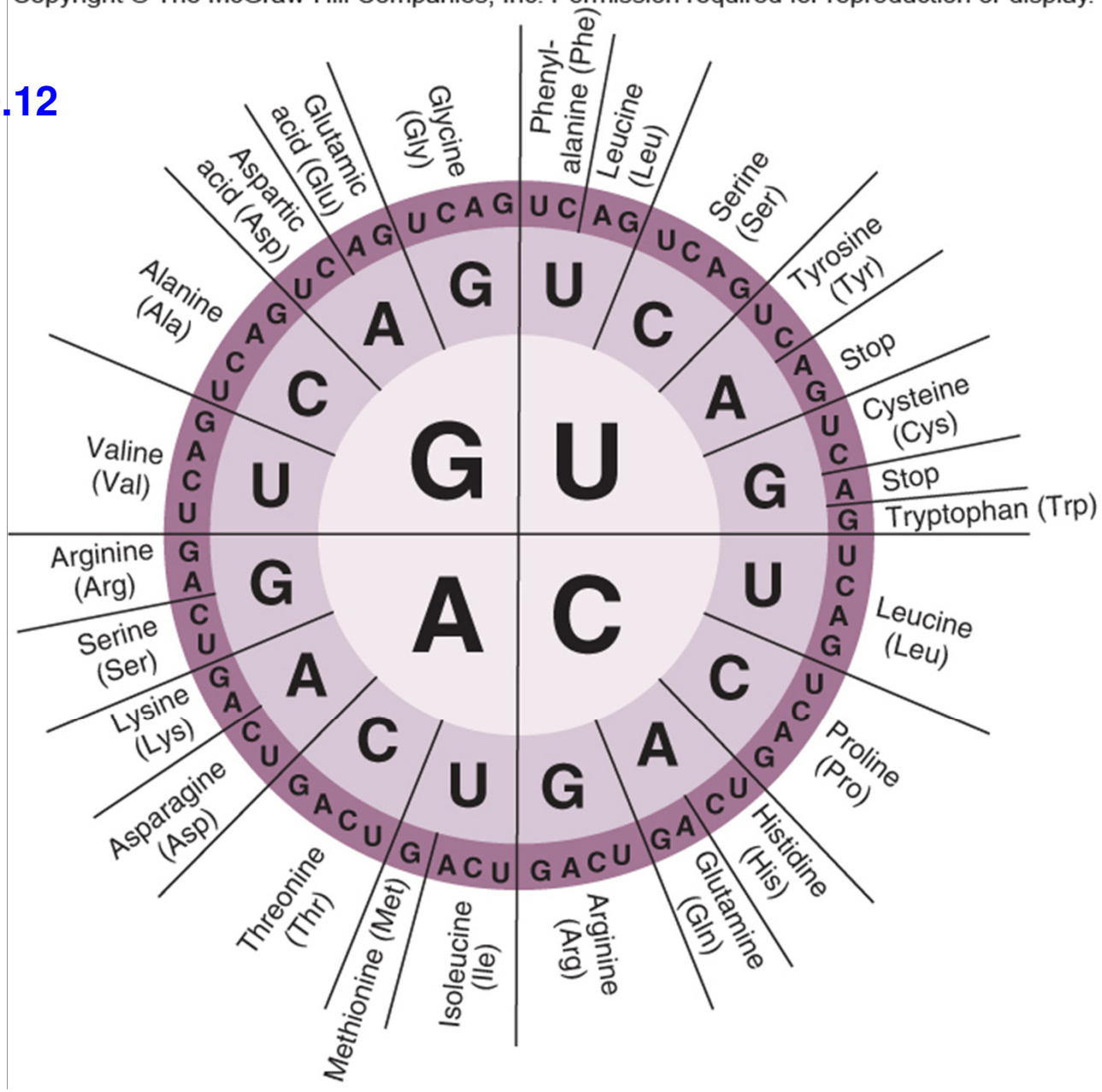
- tRNA anticodons

  UAC GGU CGU UCG AAU AUC

- Amino Acid (remember to use the codons!)

  Met Pro Ala Ser Leu (STOP)

Figure 10.12



Mutations

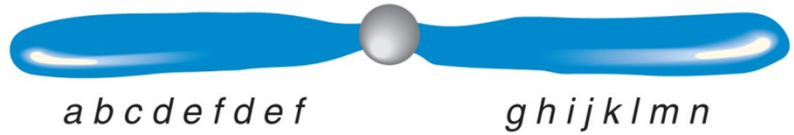
- ***Mutation*** =
  - Change in the genetic material of a cell
    - Alters DNA sequence
    - May or may not affect phenotype
  - 2 basic categories:
    - Chromosomal mutations
    - Gene mutations

Chromosomal Mutations

- ***Deletion*** =
  - Loss of part of a chromosome
- ***Duplication*** =
  - Extra copy of a part of chromosome
- ***Inversion*** =
  - Reverses direction of parts of chromosome

a. Normal sequence of genes

b. Deleted sequence of genes



c. Duplicated sequence of genes

d. Inverted sequence of genes

- ***Translocation*** =
  - Part of one non-homologous chromosome breaks off and attaches to another

- ***Insertion*** =
  - Insertion of a larger sequence into a chromosome
  - Due to unequal crossing over during meiosis

Gene Mutations

- ***Substitution*** =
  - One base is changed to a different base
  - Results in change of one codon
  - Examples
    - ***Missense mutation*** =
      - One amino acid is altered
    - ***Nonsense mutation*** =
      - Protein is shortened because new codon is a "STOP" codon
    - ***Silent mutation*** =
      - No change in amino acid
      - 3rd base of triplet was altered to codon that specifies the same amino acid

- ***Frameshift mutations*** =
  - Shifts “reading frame” of genetic message
  - Alters every amino acid that follows the mutation
  - Examples
    - ***Insertion*** =
      - One base is added to DNA sequence
    - ***Deletion***
      - One base is removed from DNA sequence
- Note: If bases are inserted/deleted in multiples of 3, reading frame is not altered

- Harmful effects
  - Cancer and other genetic disorders
- Beneficial effects
  - Resistance
  - ***Polyploidy*** = extra sets of chromosomes
    - Results in larger and stronger plants
  - Increase genetic variability in a species
- Many mutations are neutral
  - May not even change any amino acids

9. GENETIC ENGINEERING

Chapter 15

- ***Genetic Engineering*** =
  - Manipulating the genetic material to produce desirable functions that would not occur naturally

- Examples:
  - ***Selective breeding*** =
    - The intentional breeding of organisms to produce offspring with certain desirable characteristics
    - Hybridization
      - Ex: Combine disease resistance with food producing capacity
    - Inbreeding
      - Risk: Could increase likelihood of genetic defects

- ***Biotechnology*** =
  - The manipulation of living organisms to produce useful products
  - Introduce mutations to increase variation
- ***Recombinant DNA*** =
  - DNA produced by combining DNA from different sources
- ***Cloning*** =
  - Uses single cell of an adult to grow a genetically identical organism
  - Egg cell whose nucleus was removed is fused with a donor cell

Applications

- Agriculture
  - Produce less expensive and more nutritious food
  - Improve crop resistance to insects and herbicides
  - Increase crop yields without using pesticides
  - Increase milk production and produce leaner meat
- Medicine
  - Preventing and treating disease
    - ***Gene therapy*** =
      - Replacing an absent or faulty gene with a normal working one
  - Medical research
  - Genetic testing

PROS (+)

- Prevent human diseases through early detection
- Treat and possibly cure diseases
- Reproduce human organs for transplants
- Increase crop resistance to harsh conditions and pests
- Improve taste and nutritional value of crops
- Lower food cost by improving crop yield
- Identify remains of unknown soldiers
- Help solve crimes
- Could increase genetic diversity

CONS (-)

- Threaten beneficial organisms
- Creation of new pathogens
- Harmful side effects
- Expensive
- Moral/Ethical concerns
  - Health insurance or employment manipulation?
  - “Designer” offspring?
- Irreversible effects with unknown consequences
- Could decrease genetic diversity (ie-cloning)

10. ECOLOGY

- ***Biotic factors*** =
  - Living components in the environment
  - Ex: Other organisms that serve as food, predators, competition, etc.

- ***Abiotic factors*** =
  - Chemical and physical components of the environment (nonliving)
  - Ex: Sunlight, temperature, precipitation, pH, salinity, soil type, etc.

- ***Species*** =
  - Group of similar organisms that can breed and produce fertile offspring

- ***Population*** =
  - Group of individuals of the same species that live in the same area
- ***Community*** =
  - Group of different, interacting species that live in the same area
- ***Ecosystem*** =
  - All of the organisms that live together, interacting with their physical environment
- ***Biome*** =
  - Group of ecosystems that share similar climates and typical organisms
  - Grouped geographically

Biomes

- Tropical Rain Forest
  - Thin, nutrient poor soil
  - Hot; very wet
- Tropical Savanna
  - Frequent fires
  - Hot; dry and wet seasons
- Desert
  - Thin, porous, nutrient poor soil
  - Hot days, cold nights; very dry

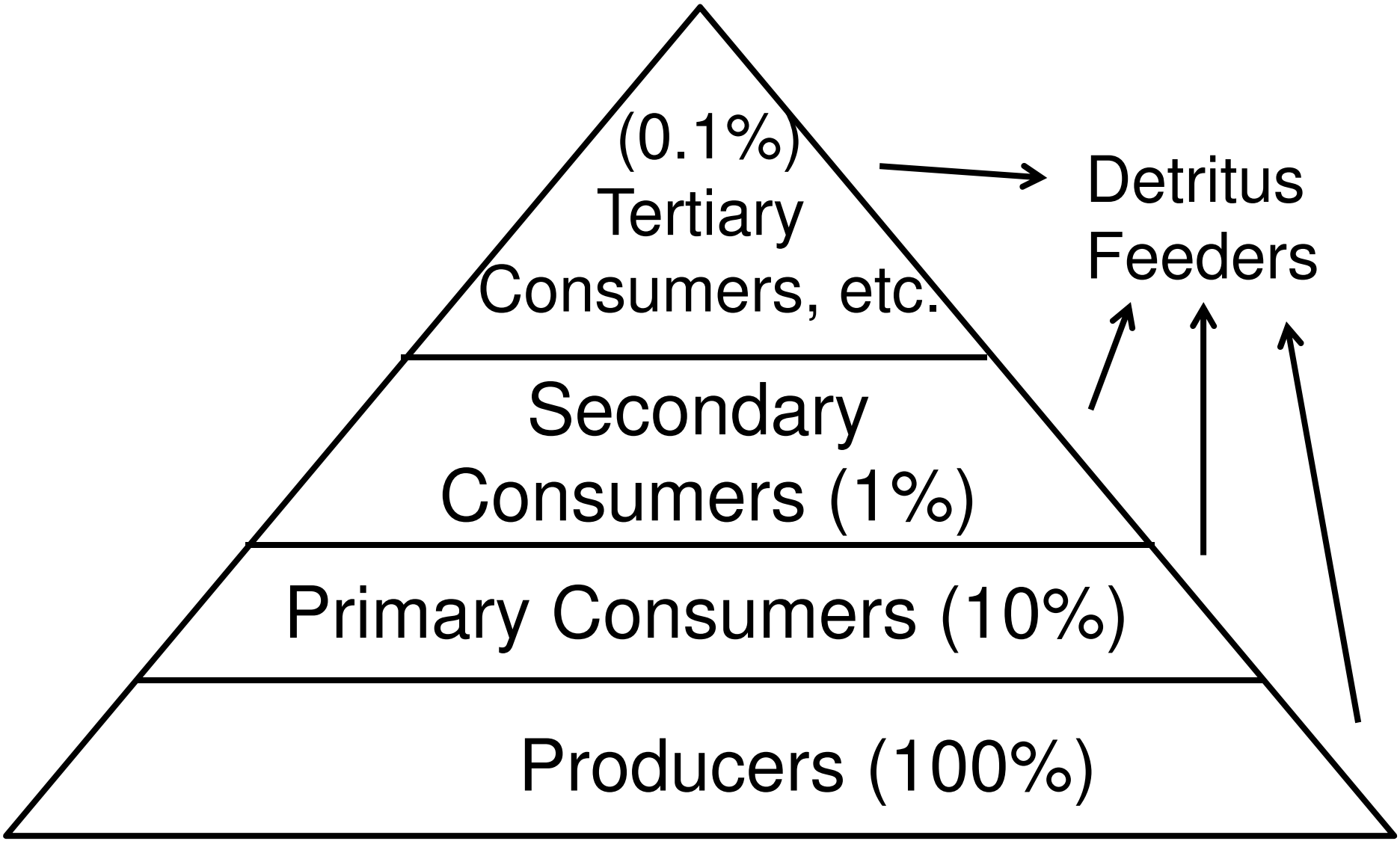
- Temperate Grassland
  - Fertile soil
  - Warm/hot summers, cold winters; moderate precip.
- Temperate Forest
  - Fertile soil
  - Warm/hot summers, cold winters; moderate precip.
- Coniferous Forest
  - Acidic soil
  - Short summers, cold winters; less precip.
- Tundra
  - Permafrost
  - Long, cold winters; low precip.

Energy Flow

- **Autotrophs/producers**
  - Make their own food
- **Heterotrophs**
  - **Consumers**
    - Consume living organisms
  - **Detritus feeders/decomposers**
    - Feed on dead organisms

- All food webs must start with producers
- Arrows show flow of ENERGY
- Only 10% of energy is passed from one organism to another
  - Some is broken down to do work
  - Some is lost as heat and waste

Biomass and Energy Pyramids



Interactions

- Organisms avoid competition by developing ***niches*** =
  - Role and position an organism has in ecosystem
  - "Job"
- ***Keystone species*** =
  - Essential for survival of many other species
  - Examples
    - Starfish prevent mussels from crowding out other organisms
    - Otters prevent urchins from eating entire kelp habitat

- ***Parasitism*** =
  - One organism benefits while other is harmed
  - Ex: Tick and dog
- ***Mutualism*** =
  - Both organisms benefit
  - Ex: Clownfish and anemone
- ***Commensalism*** =
  - One organism benefits and other is unaffected
  - Ex: Remora and shark

11. EVOLUTION

- ***Adaptation*** =
  - Characteristic that increases an organism's ability to survive and reproduce in an environment
  - Inherited, NOT acquired
  - Examples
    - To cope with climate: thick fur, hibernation
    - To obtain food and water: long neck, web
    - To defend against predators: camouflage, armor
    - To attract mates: calls, exotic feathers

- ***Natural selection*** =
  - Organisms that are most suited to their environment survive and reproduce
  - Acts only on inherited traits
    - NOT acquired characteristics
  - Mechanism for evolution
  - Ex: Peppered moths

- ***Homologous structures*** =
  - Similar structures in different species of common ancestry
    - Front limbs of vertebrates
  - Supports descent with modification from common ancestor
- ***Analogous structures*** =
  - Share common function, not structure
    - Wing of bee and bird
  - Not the clue to common descent
- ***Vestigial structures*** =
  - Inherited from ancestors but lost much or all of original function

- Populations evolve
  - NOT individuals!
- Mutations are a source of genetic variation
- ***Genetic drift*** =
  - A change in the gene pool of a small population that takes place strictly by chance
    - Does not produce adaptations since it is random
  - Bottleneck and founder effects

- New species can form when they become reproductively isolated
  - ***Behavioral isolation*** =
    - Organisms develop differences in courtship rituals
  - ***Geographic isolation*** =
    - Organisms are separated by physical barriers like water or mountains
  - ***Temporal isolation*** =
    - Organisms reproduce at different times